REMARKS

In the Office Action of October 4, 2004, claims 1-6, 8-11, and 13-20 were rejected under 35 U.S.C. §102(b) as being anticipated by JP 2002-283069 (hereinafter Tatsuo). Additionally, claims 7 and 12 were rejected under 35 U.S.C. §103(a) as being obvious over Tatsuo in view of U.S. Pat. No. 5,580,622 (hereinafter Lockshaw).

Applicant has herein amended claim 1 and has added new claims 21 and 22. Applicant submits the ensuing remarks in support of the allowability of claims 1-22. The remarks set forth herein are at least partially based on Applicant's understanding of Tatsuo as aided by a Japanese computerized translation of Tatsuo obtain via the Japanese Patent Office website (enclosed as Exhibit A).

Claims 1-22 Are Neither Anticipated Nor Made Obvious By The Prior Art

Independent claim 1 requires, among other things, the first member to comprise a thin sheet portion of material and at least two protuberances that extend outwardly from the first face of the sheet portion. The protuberances together form the opposing restraining surfaces that limit movement of the edge margin of the second member relative to the first member during the step of stir welding. In contrast, Tatsuo discloses the formation of a groove that extends into the sheet portion of material, but not the formation of protuberances. This is significant in that, as shown in Figures 3 and 4 of Tatsuo, portions of the groove remain present after the assembly has been stir welded. This cannot be avoided by stir welding through the entire thickness of the sheet portion because doing so would eliminate the groove's ability to limit the deflection of rib member during the stir welding operation. This being said, such portions of the groove

remaining after the stir welding process create stress risers that reduce the strength of the sheet of material at the T-joint. Such stress risers are not created in the assembly of claim 1 since the protuberances limit the relative movement between the first and second members in a manner such that the welded material of the T-joint can extend through the entire thickness of the sheet portion. Thus, the welded material in the assembly of claim 1 does not create a stress riser and therefore significantly improves the overall strength of the welded assembly. Hence, the friction stir welded assembly of claim 1 has significant advantages over the friction stir welded assembly disclosed in Tatsuo, due in part to the protuberances as claimed. It follows then that, because Tatsuo fails to disclose or suggest a first member having protuberances as claimed, Tatsuo fails to anticipate or make obvious claim 1. As such, the rejection of claim 1 under 35 USC §102 is improper and should be withdrawn.

Moreover, although Lockshaw discloses an assembly comprising protuberances, Lockshaw is concerned with the formation of shrink fit structures as inexpensive substitutes to materials such as honeycomb, and is not concerned with any type of friction stir welded T-joint assembly. In most circumstances, is more difficult to fabricate the T-joint assembly of claim 1 than it is to form the friction stir welded T-joint assembly disclosed in Tatsuo. The teachings of Lockshaw do not suggest the creation of a more complex or expensive assembly in place of another simpler or less expensive assembly. Thus, absent the hindsight gleamed from the present disclosure, there would be no reason to combine the teachings of Lockshaw and Tatsuo to create the friction stir welded T-joint assembly of claim 1. As such, claim 1 is not obvious in view of Lockshaw and Tatsuo.

In view of the foregoing, it follows that, claims 2-7, being dependant upon claim 1, are neither anticipated by nor obvious in view of the prior art. Thus, the rejections of claims 2-7 are also improper and should be withdrawn.

In addition to being dependant upon claim 1, claim 2 requires one of the first and second members to comprise a tooling portion forming a portion of the monolithic piece thereof. Moreover, claim 2 requires a step of securing the first and second members to a stir welding apparatus via the tooling portion during the step of stir welding the first member to the second member and a step of separating the tooling portion from the first and second members after stir welding the first member to the second member. The Office Action identifies a portion of the friction stir welding tool (1) disclosed in Tatsuo as being an equivalent "tooling portion." However, the stir welding tool (1) disclosed in Tatsuo is not a "tooling portion" as claimed because it is not a portion of either the first or second members and it is not used to secure the first and second members to any friction stir welding apparatus. Nonetheless, Applicant notes that one of the members disclosed in Tatsuo, namely the member identified by reference numeral (15), does have similarities to one of the members of the preferred embodiment disclosed in the present application and that, with hindsight gleamed from the present application, such a member might initially appear to have a tooling portion. However, based on Applicant's understanding of Tatsuo, Tatsuo does not disclose the use of such member to as a "tooling portion" nor does it disclose or suggest the separation of any such portion from any assembly after the member has been friction stir welded to another member. In fact, in view of Figure 5 of Tatsuo, it appears that the entire member (15) forms a portion of the finished bumper (13) and it would therefore be problematic to

remove any portion of the member (15) after the friction stir welding process. As such, Tatsuo does not disclose or suggest any step of separating a tooling portion from the first and second members as required by claim 2, and does not disclose the use of either of the first and second members as tooling during the friction stir welding process. Thus, for these additional reasons, claim 2 is further neither anticipated by nor obvious in view of the prior art. It follows then that claims 3 and 4, being dependant upon claim 2 are similarly further neither anticipated by nor obvious in view of the prior art.

Independent claim 8 requires, among other things, steps of forming first and second members in a manner such that one of the first and second members to comprises a tooling portion formed as a contiguous portion of the material thereof, utilizing a stir welding apparatus to stir weld the edge margin of rib of the second member to the sheet portion of the first member while the first and second members are secured to the stir welding apparatus via the tooling portion, and separating the tooling portion from the first and second members after forming the stir welded T-joint. As discussed above in reference to claim 2, Tatsuo fails to disclose any such tooling portion or any step of utilizing a stir welding apparatus to stir weld first and second members to each other while the first and second members are secured to the stir welding apparatus via the tooling portion. Thus, Tatsuo fails to anticipate or make obvious claim 8. As such, it also follows then that claims 9-15 and 21, being dependant upon claim 8, are, for the same reasons, neither anticipated by nor obvious in view of the prior art.

Claim 16 is directed to a T-joint that comprises, among other things, a sheet member that is stir welded to a rib member. Claim 16 also requires that the sheet

member comprise a restraining surface that is engaged with the first face of the rib member and a restraining surface that is engaged with the second face of the rib member. The elements of the Tatsuo assembly identified in the Office Action as being such restraining surfaces are not shown as being engaged with any surface of the rib member, either before or after the members are friction stir welded together. Moreover, Tatsuo discloses that such surfaces are purposely spaced from the opposite face of the rib so as to leave a gap for friction still welded material to flow into. Thus, Tatsuo teaches away from configuring a T-joint as recited by claim 16. Thus, because Tatsuo fails to disclose each and every limitation of claim 16, Tatsuo fails to anticipate or make obvious claim 16. As such, it also follows then that claims 17-20 and 22, being dependant upon claim 16, are, for the same reasons, neither anticipated by nor obvious in view of the prior art.

CONCLUSION

In view of the above, Applicant submits that this application is now in condition for allowance and notification of such is respectfully requested.

Respectfully submitted,
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TECHNICAL FIELD

[Field of the Invention] This invention relates the structural member made from an aluminium alloy of an automobile for frames to the approach of carrying out comparison junction of a T character mold, especially the friction stirring junction approach.

PRIOR ART

[Description of the Prior Art] As for the structural member for frames of an automobile, many aluminium alloys have come to be used from a viewpoint of lightweight-izing of a car. There was a possibility that may soften such a structural member made from an aluminium alloy near the joint with the welding heat although arc welding, such as TIG and MIG, is common as an approach of carrying out comparison junction of a T character mold, and reinforcement might fall.

[0003] The friction stirring junction which fit the part II material into the slot established in the part I material, and the probe for friction stirring is made to act from the field of the opposite side of the slot of the part I material, and is joined there as shown in JP,11-28581,A is known.

EFFECT OF THE INVENTION

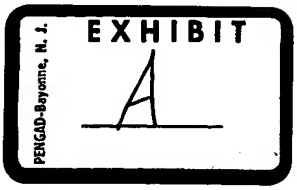
[Effect of the Invention] The reinforcement and the engine performance of structure material after junction can be satisfied without generating a cavity after junction, attaining improvement and lightweight-izing of productivity like the above according to the friction stirring junction by this invention. Moreover, in spite of permitting the clearance (clearance) resulting from process tolerance being inadequate, a joint does not have a defect, either and good junction quality can be maintained.

TECHNICAL PROBLEM

[Problem(s) to be Solved by the Invention] In the friction stirring junction shown in the above-mentioned official report, since it is joinable at temperature lower than arc welding, the fall on the strength by the heat at the time of junction can be lessened. However, in order to make heavy-gage the whole part or the 2nd whole structural member by which fitting is carried out to the slot of the 1st structural member in the 2nd structural member, there was a problem of being contrary to productivity or lightweight-ization.

[0005] Moreover, when the slot of the 1st structural member is made deep and fitting of the 2nd structural member of thin meat is carried out, Especially when the slot is prepared for the 1st structural member by casting or the 2nd configuration members are aluminium alloy extruded materials of a cross section, such as a neck ring and a rice field type The clearance (clearance) was generated between the 1st configuration member of a process tolerance top, and the 2nd structural member, and when a cavity occurred after junction, there was a problem that bonding strength fell.

[0006] So, this invention makes it the technical technical problem to offer the friction stirring junction approach to which desired reinforcement is satisfied, without generating a cavity after junction, attaining improvement and lightweight-izing of productivity.



DESCRIPTION OF DRAWINGS

[Brief Description of the Drawings]
[Drawing 1] It is the cross-sectional view in which showing 1 operation gestalt of the friction stirring junction approach by this invention, and showing the condition (before junction) of having combined the 1st configuration member and the 2nd configuration member.
[Drawing 2] It is the operation gestalt shown in drawing 1 , and is drawing of longitudinal section (A ** in drawing 1) showing the condition of inserting a probe and carrying out friction stirring.
[Drawing 3] It is the cross-sectional view showing the junction back of the operation gestalt shown in drawing 1 .
[Drawing 4] It is the cross-sectional view showing the junction back which has a defect (cavity) in a joint.
[Drawing 5] It is the perspective view showing the condition of having fixed bumper RIINHOSUMENTO in the crash box in which an example of the structure material of an automobile which enforced the approach of this invention is shown.
[Drawing 6] It is the perspective view showing the condition before combining the 1st configuration member and the 2nd configuration member of a crash box of drawing 5 .
[Drawing 7] It is the perspective view showing the condition whose 1st configuration member and 2nd configuration member of a crash box of drawing 5 are under junction.
[Drawing 8] It is drawing showing the relation between the distance from the joint in the crash box joined by this invention and the conventional welding, and a degree of hardness.
[Drawing 9] It is the load-deformation diagram showing the energy-absorbing property at the time of the collision in the crash box joined by this invention and the conventional welding.
[Drawing 10] It is the perspective view showing RIINHOSUMENTO of the instrument panel in which another example of the structure material of an automobile which enforced the approach of this invention is shown.
[Drawing 11] It is the cross-sectional view (B-B cross section in drawing 10) showing the condition (before junction) of having combined the 1st configuration member and the 2nd configuration member of RIINHOSUMENTO of drawing 10 .
[Description of Notations]
1 Fixture for Friction Stirring Junction
2 Rotator
3 Probe
4 Shoulder
5 1st Configuration Member (Configuration Member)
5a Field
6 2nd Configuration Member (Configuration Member)
7 Slot
8 The Junction Direction (Travelling Direction)
d The diameter of a probe
D The diameter of a rotator
S Clearance (clearance)
t6 Thickness

w7 Flute width
theta Advanced angle (tilt angle)
DETAILED DESCRIPTION

[Detailed Description of the Invention]
[0001]
[Field of the Invention] This invention relates the structural member made from an aluminium alloy of an automobile for frames to the approach of carrying out comparison junction of a T character mold, especially the friction stirring junction approach.
[0002]
[Description of the Prior Art] As for the structural member for frames of an automobile, many aluminium alloys have come to be used from a viewpoint of lightweight-izing of a car. There was a possibility that may soften such a structural member made from an aluminium alloy near the joint with the welding heat although arc welding, such as TIG and MIG, is common as an approach of carrying out comparison junction of a T character mold, and reinforcement might fall.
[0003] The friction stirring junction which fit the part II material into the slot established in the part I material, and the probe for friction stirring is made to act from the field of the opposite side of the slot of the part I material, and is joined there as shown in JP,11-28581,A is known.
[0004]
[Problem(s) to be Solved by the Invention] In the friction stirring junction shown in the above-mentioned official report, since it is joinable at temperature lower than arc welding, the fall on the strength by the heat at the time of junction can be lessened. However, in order to make heavy-gage the whole part or the 2nd whole structural member by which fitting is carried out to the slot of the 1st structural member in the 2nd structural member, there was a problem of being contrary to productivity or lightweight-ization.
[0005] Moreover, when the slot of the 1st structural member is made deep and fitting of the 2nd structural member of thin meat is carried out, Especially when the slot is prepared for the 1st structural member by casting or the 2nd configuration members are aluminium alloy extruded materials of a cross section, such as a neck ring and a rice field type The clearance (clearance) was generated between the 1st configuration member of a process tolerance top, and the 2nd structural member, and when a cavity occurred after junction, there was a problem that bonding strength fell.
[0006] So, this invention makes it the technical technical problem to offer the friction stirring junction approach to which desired reinforcement is satisfied, without generating a cavity after junction, attaining improvement and lightweight-izing of productivity.
[0007]
[Means for Solving the Problem] The friction stirring junction approach by this invention devised in order to solve the above-mentioned technical technical problem The slot of bigger width of face than the thickness of the 2nd structural member is established in one field of the 1st structural member. In the friction stirring junction approach which attaches the 2nd structural member to this slot, inserts the probe which protruded at the tip of a rotator from the field of another side of the 1st structural member, is made to carry out friction stirring, and carries out the heading joint of a T character mold So that the ingredient of the 1st stirred structural member and the 2nd structural member may carry out plastic flow and it may be filled up with the clearance between the 1st structural member and the 2nd structural member in said slot The

diameter of the shoulder section of said rotator is 2.5 or more times of the diameter of said probe. Said probe is characterized by for 3 degrees or more inclining and carrying out friction stirring of the tilt angle to the perpendicular of the front face near [where friction stirring of said 1st structural member is carried out] the part in the direction in which the shoulder behind [junction direction] said rotator eats into the 1st structural member.

[0008] Desired reinforcement can be satisfied in the friction stirring junction by above-mentioned this invention, without generating a cavity after junction, since the ingredient of the stirred structural member carries out plastic flow and is filled up with the clearance between slots.

[0009]

[Embodiment of the Invention] Hereafter, the gestalt of operation of this invention is explained based on a drawing.

[0010] They are the cross-sectional view in which drawing 1 and drawing 2 showing 1 operation gestalt of the friction stirring junction approach by this invention, and showing the condition that drawing 1 combined the 1st configuration member 5 and the 2nd configuration member 6, and drawing of longitudinal section (A ** in drawing 1) showing the condition of drawing 2 inserting a probe 3 and carrying out friction stirring.

[0011] As shown in drawing 1 , a slot 7 is established in one field of the 1st structural member 5, and the 2nd configuration member 6 is attached to this slot 7. Since the flute width w7 of a slot 7 is set up more greatly than the thickness t6 of the 2nd configuration member 6, where the 2nd configuration member 6 is attached to the 1st configuration member 5, in the slot 7, Clearance S has produced it between the 1st configuration member 5 and the 2nd configuration member 6.

[0012] Moreover, the fixture 1 for friction stirring junction consists of a cylinder-like rotator 2 and a probe 3 which protruded at the tip on the revolving shaft 10 of a rotator 2, and can be rotated with a driving gear (not shown) at high speed. The diameter d of a probe 3 is smaller than the diameter D of the rotator 2 in a shoulder 4, and is set up more greatly than the flute width w7 of the slot 7 of the 1st configuration member 5. The shoulder 4 of a rotator 2 serves as a concave surface which inclined toward the probe 3 from the periphery, and the tip of a probe 3 is formed spherically. In addition, in order to carry out friction stirring effectively, it ****s to the peripheral face of a probe 3, and irregularity, such as structure, may be formed.

[0013] The junction to the 1st configuration member and the 2nd configuration member, rotating a rotator 2 and a probe 3 at high speed, as shown in drawing 2 Where the 2nd configuration member 6 is attached to a slot 7, from opposite field 5a of the slot 7 of the 1st configuration member 5 It inclines on the advanced square theta a rotator 2 and whose probe 3 are the tilt angles of the revolving shaft 10 over the perpendicular 11 of field 5a in the direction in which shoulder 4a behind [junction direction 8] a rotator 2 eats into field 5a of the 1st structural member 5. While making a probe 3 insert so that the 2nd configuration member 6 may be attained to, friction stirring junction is performed by contacting the shoulder 4 of a rotator 2 to field 5a of the 1st configuration member 5, and moving it along a slot 7.

[0014] At this time, by rotating a rotator 2, frictional heat occurs in sliding with a probe 3 and a shoulder 4, and the configuration members 5 and 6, and the ingredient of the configuration members 5 and 6 near the contact section of the fixture 1 for friction stirring junction can be made to be able to stir with softening, can carry out plastic flow, can be filled up with Clearance S, and can join the 1st configuration member 5 and the 2nd configuration member 6.

[0015] That is, the ingredient of the fusion zone 9 (it sets to drawing 2 and is the place of a cross-section triangle) of the 1st configuration member 5 which it is near the contact section of the

shoulder 4 in the rotator 2 which inclines on the advanced square theta carries out plastic flow, is mixed with the ingredient of the other parts of the 1st configuration member, and the 2nd configuration member, and it is filled up with Clearance S, and as shown in drawing 3 , the joint 12 without a cavity is obtained.

[0016] Since the effectiveness to which less than 2.5 times or the advanced angle theta of the diameter d of a probe 3 carries out plastic flow of the ingredient of the configuration members 5 and 6 at less than 3 degrees does not have the enough diameter D of the shoulder 4 section of a rotator 2 here, 2.5 or more times of a diameter d and the advanced angle theta have [a diameter D] desirable 3 degrees or more. Furthermore, the diameter D of this rotator 2 and the advanced angle theta are synthetically determined in consideration of the effect by the tooth space and frictional heat of a joint etc.

[0017] Next, the example of this invention is concretely explained as compared with the example of a comparison.

[0018] An example and the example of a comparison to drawing 1 and the 1st configuration member 5 which is the aluminium alloy rolled stock (A5052) whose thickness t5 is 5mm in a gestalt as shown drawing 2 Form the slot 7 of the flute width w7 which the depth h7 shows in Table 1 by 4mm, and the 2nd configuration member 6 which is an aluminium alloy extruded material (A6N01-T5) whose thickness t6 is 2mm is attached to this slot 7. From field 5a, the fixture 1 for friction stirring junction of the diameter D shown in Table 1 and a diameter d was inserted on the advanced square theta, and friction stirring junction was performed on condition that rotational-speed 2500rpm and junction rate (passing speed) 300 mm/min. In addition, also in which fixture 1 for friction stirring junction, a globular shape and die-length L set the shoulder 4 the concave surface, and the tip set the probe 3 to 4.5mm.

[0019] After fully carrying out cooling solidification, junction nature evaluation was performed by investigating the appearance and the interior of a joint 2. For example, if the interior has a defect like cavernous 22b even if appearance 22a of a joint 22 does not have a defect as shown in drawing 4 , junction nature will be spoiled greatly. Then, visually, the appearance judged the interior to be O, if ** and a defect were not accepted when the existence of a defect (a cavity is also included) was investigated, there was a defect beyond phi1mm in an appearance and the interior of each by observation of radioparency equipment and ****** and there were x and a defect below phi1mm. These results were also collectively shown in Table 1.

[0020]

[Table 1]

[0021] As shown in Table 1, as for 2.5 times of the diameter d of a probe 3, and the examples 1-6 which made the advanced angle theta 3 degrees, an appearance and the interior were not accepted in the diameter D of a rotator 2, as for the defect, but all have checked the good thing of junction nature compared with the examples 7-12 of a comparison. The cavity is generated inside and the examples 7-12 of a comparison became clear [the bad thing of junction nature], although there was also an example a defect is not accepted to be to an appearance to it.
[0022] As mentioned above, according to the friction stirring junction by this invention, even if it is the heading joint of a T character mold with the clearance S needed on process tolerance and attachment, the plastic flow of the ingredient by friction stirring is filled up with Clearance S, there is no cavity after junction, and desirable structure material can be obtained on reinforcement with sufficient junction nature. Moreover, by having established the slot 7 in the 1st structural member, there are also few location gaps at the time of junction, and attachment nature is also good.
[0023] Furthermore, while there are also few falls on the strength by junction as compared with junction of other arc welding etc., for example, fixing bumper RIINHOSUMENTO 13 which is the structure material of an automobile as shown in drawing 5 , even if it carries out in the crash box 14 which absorbs the impact at the time of the collision of a car, the outstanding engine performance can be obtained.
[0024] As the crash box 14 is shown in drawing 6 , to the 1st configuration member 15 which is the aluminum rolled stock (A5052) whose thickness t15 is 5mm As the 2nd configuration member 16 which is an aluminium alloy extruded material (A6N01-T5) of the rice field type cross section (an outer wall is 100x60mm and direction-of-extrusion die length of 200mm) whose thickness is 2mm is attached and it is shown in drawing 7 From field 15a of the 1st configuration member 15, friction stirring junction is carried out on the same fixture 1 for friction stirring junction and same conditions as examples 1-6. The slot 17 with a flute width of 2.2-2.7mm is established in the rice field type in a depth of 4mm so that the 2nd configuration member 16 may clinch the opposite field of field 15a of the 1st configuration member 15.
[0025] Having the engine performance which is larger than the conventional arc welding and is excellent as the amount of energy-absorbing at the time of it turning out that the field near [by heat / which carried out the degree-of-hardness fall] the joint is small compared with the conventional arc welding, and making the direction of extrusion of the 2nd configuration member 16 carry out axial collapse of the crash box 14 is shown in drawing 9 understands in the crash box 14 joined by the friction stirring junction by this invention as shown in drawing 8 .
[0026] Similarly, you may carry out to RIINHOSUMENTO 23 of the instrument panel which is the structural member of an automobile as shown in drawing 10 . As shown in drawing 11 (B-B cross section in drawing 10), RIINHOSUMENTO 23 To the 1st configuration member 25 (attaching member) which is aluminum die-casting material (ADC12) whose thickness t25 is 5mm Thickness t26 attaches the 2nd configuration member 26 which is an aluminium alloy extruded material (A6N01-T5) of the circular cross section (diameter of 70mm) which is 1.6mm, and friction stirring junction is carried out from field 25a of the 1st configuration member 25 on the same fixture 1 for friction stirring junction and same conditions as examples 1-6. However, although the slot 27 where the draft has a depth of 4mm and a flute width w27 by 2.0mm is established in the circle type by making the advanced angle theta into 4 degrees so that the 2nd configuration member 26 may clinch the opposite field of field 25a of the 1st configuration member 25, the ingredient of the configuration members 25 and 26 carries out plastic flow by

friction stirring, and it can be filled up with a clearance S2 and can consider as junction without a cavity.

[0027]

[Effect of the Invention] The reinforcement and the engine performance of structure material after junction can be satisfied without generating a cavity after junction, attaining improvement and lightweight-izing of productivity like the above according to the friction stirring junction by this invention. Moreover, in spite of permitting the clearance (clearance) resulting from process tolerance being inadequate, a joint does not have a defect, either and good junction quality can be maintained.

CLAIMS

[Claim(s)]

[Claim 1] The slot of bigger width of face than the thickness of the 2nd structural member is established in one field of the 1st structural member. In the friction stirring junction approach which attaches the 2nd structural member to this slot, inserts the probe which protruded at the tip of a rotator from the field of another side of the 1st structural member, is made to carry out friction stirring, and carries out the heading joint of a T character mold So that the ingredient of the 1st stirred structural member and the 2nd structural member may carry out plastic flow and it may be filled up with the clearance between the 1st structural member and the 2nd structural member in said slot The diameter of the shoulder section of said rotator is 2.5 or more times of the diameter of said probe. The friction stirring junction approach characterized by for 3 degrees or more of said probes inclining, and carrying out friction stirring of the tilt angle to the perpendicular of the front face near [where friction stirring of said 1st structural member is carried out] the part in the direction in which the shoulder behind [junction direction] said rotator eats into the 1st structural member.